

CHAPTER 4

SUMMARY OF TROPICAL CYCLONES 1970

SUMMARY OF WESTERN PACIFIC
TROPICAL CYCLONES
OF 1970

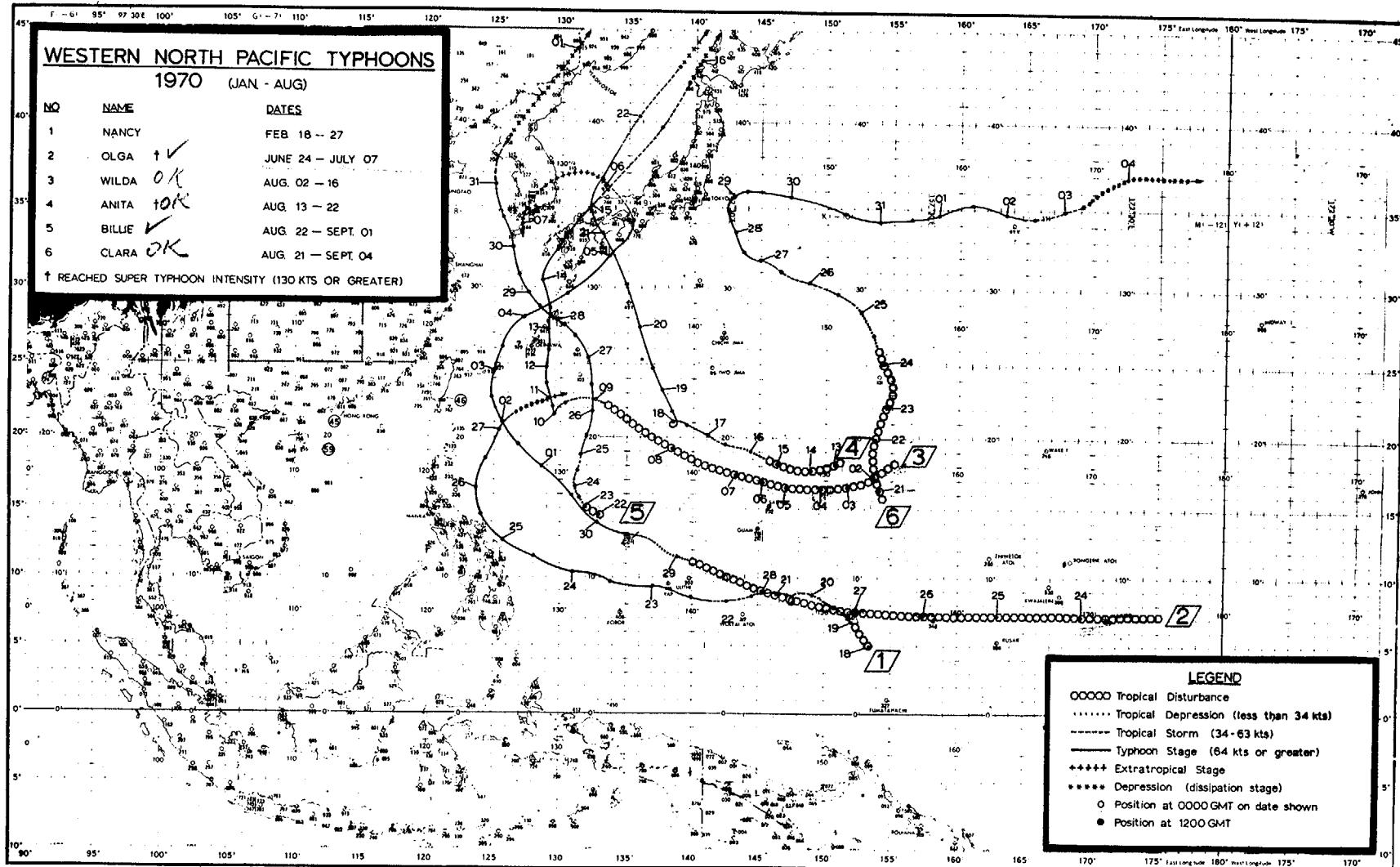
	<u>1960-1969</u> <u>(AVE)</u>	<u>1969</u>	<u>1970</u>
TOTAL NUMBER OF WARNINGS	750	430	533
CALENDAR DAYS OF WARNING	153	108	127
NUMBER OF WARNING DAYS WITH TWO OR MORE CYCLONES	56	15	29
NUMBER OF WARNING DAYS WITH THREE OR MORE CYCLONES	14	1	0
TROPICAL DEPRESSIONS	6	4	3
TROPICAL STORMS	10	6	12
TYPHOONS	20	13	12
TOTAL TROPICAL CYCLONES	36	23	27

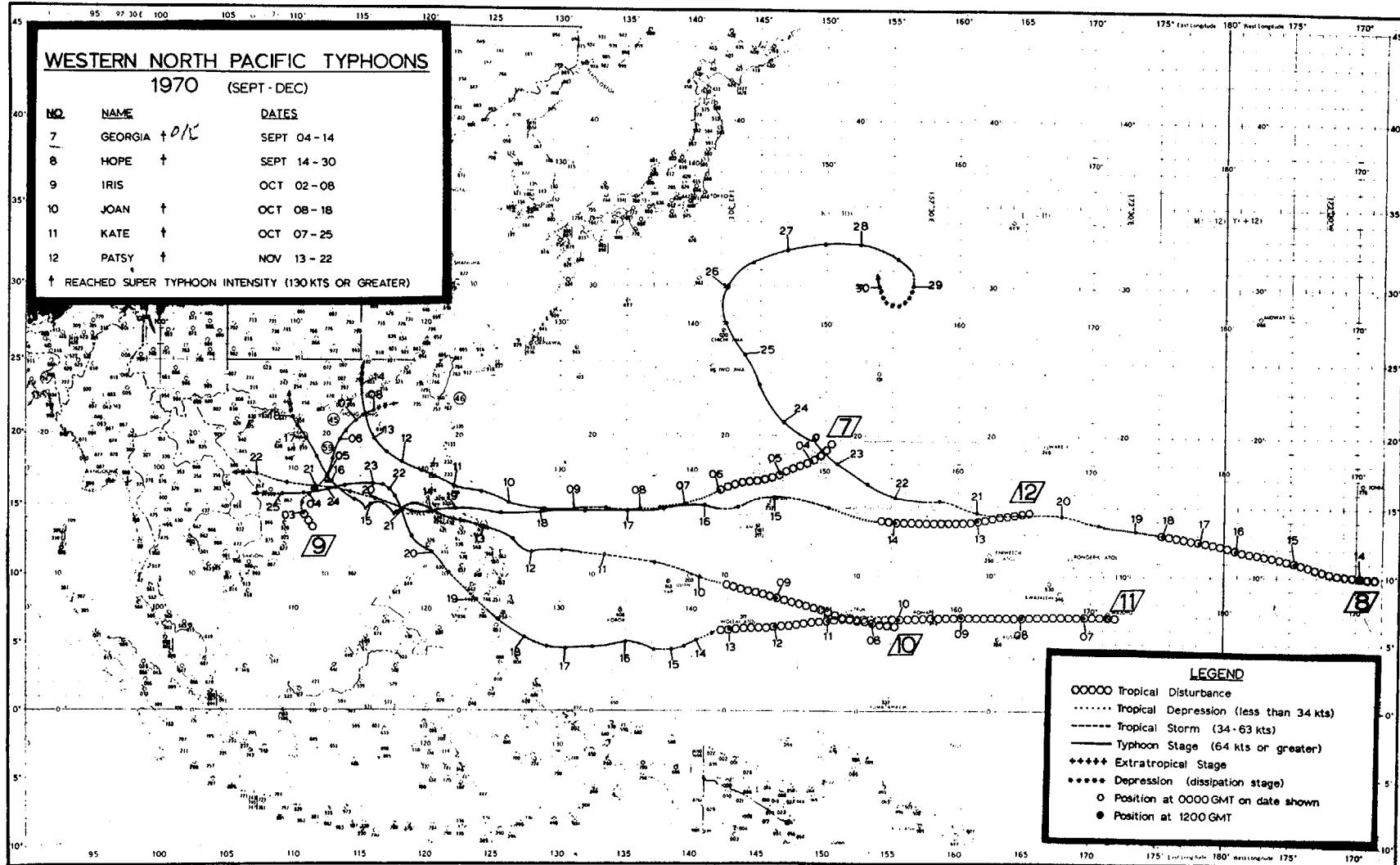
TABLE 4-1

SUPER TYPHOONS DURING 1970

<u>CYCLONE NUMBER</u>	<u>NAME</u>	<u>INCLUSIVE DATES</u>	<u>MAX INTENSITY</u>	<u>MIN SLP</u>	<u>MIN 700 MB HT</u>
02	OLGA	28 JUN-05 JUL 130-140	KNOTS	904 MB	2268 m
11	ANITA	16 AUG-22 AUG 125-135	KNOTS	912 MB	2325 m
17	GEORGIA	07 SEP-14 SEP 130-140	KNOTS	904 MB	2390 m
18	HOPE	19 SEP-29 SEP 140-150	KNOTS	895 MB	2219 m
21	JOAN	09 OCT-18 OCT 135-150	KNOTS	901 MB	2332 m
22	KATE	14 OCT-25 OCT 130-135	KNOTS	938 MB	2554 m
27	PATSY	14 NOV-22 NOV 120-135	KNOTS	918 MB	2256 m

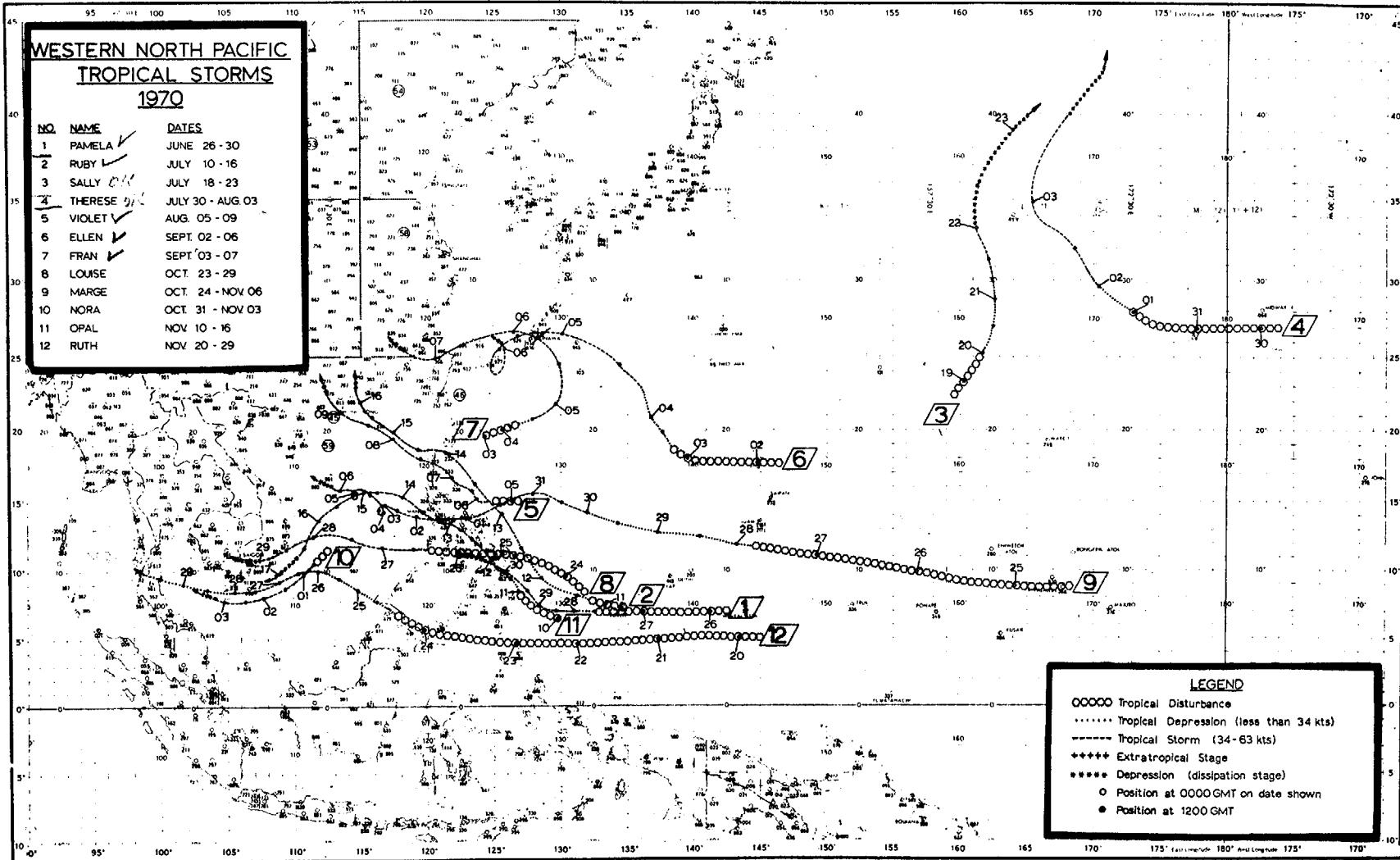
TABLE 4-2





**WESTERN NORTH PACIFIC
TROPICAL STORMS
1970**

NO.	NAME	DATES
1	PAMELA ✓	JUNE 26 - 30
2	RUBY ✓	JULY 10 - 16
3	SALLY ✓	JULY 18 - 23
4	THERESA ✓	JULY 30 - AUG 03
5	VIOLET ✓	AUG. 05 - 09
6	ELLEN ✓	SEPT. 02 - 06
7	FRAN ✓	SEPT. 03 - 07
8	LOUISE	OCT. 23 - 29
9	MARGE	OCT. 24 - NOV 06
10	NORA	OCT. 31 - NOV 03
11	OPAL	NOV 10 - 16
12	RUTH	NOV. 20 - 29



GENERAL SUMMARY, WESTERN PACIFIC TYPHOON SEASON OF 1970

Twenty four tropical storms were observed in the West Pacific during the 1970 season, twelve of which developed to typhoon strength. Hurricane Dot¹ came close to being added to the list but veered off to the northeast after approaching within 30 miles of the International Date Line northwest of Midway Island.

Although the number of tropical storms (24) was only one less than the average for the past 25 year period, this is the second consecutive season that typhoon frequency has been below normal. 1970 was the lightest year for typhoon activity in two decades (tying a previous low in 1950) and compares with an average of 18 since 1945² (see Table 4-3). The number of typhoon days, however, actually saw an increase of 17 days over 1969 as storms were longer lived (see Table 4-4).

AVERAGE MONTHLY FREQUENCY OF TYPHOONS IN THE WESTERN NORTH PACIFIC DURING PERIOD 1945-1969 COMPARED WITH 1970 SEASON

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1945-69	.3	*	.2	.6	.9	1.1	2.4	3.6	3.2	2.8	1.9	.8	17.9
1970	0	1	0	0	0	1	0	4	2	3	1	0	12

*Less than .05

TABLE 4-3

An uncommon feature this year was the off-season Typhoon Nancy. The unlikelihood of such an event is evidenced in the fact that only one other storm reaching typhoon force has been recorded during the month of February since 1945.

One can only conjecture as to the reasons for the low total of typhoons in 1970. Except for August the subtropical ridge was not consistently developed in either strength or longitudinal extent during the major typhoon months. This inhibited a regime for a persistent fetch of developed easterlies across the climatological development zone of the West Pacific.

¹Name Dot was transferred from West Pacific list to hurricane which developed in the Central Pacific.

²Records compiled by U. S. agencies began in 1945; JTWC established in 1959.

TYPHOON DAYS 1959-1970

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL PER YEAR
1959	---	---	---	8	---	---	3	18	19	18*	10*	18	94
1960	---	---	---	2	---	10	13	36*	--	23*	2	12	98
1961	---	---	8	---	8	2	10*	15	23*	17*	6	6	95
1962	---	---	---	7	4	---	14*	37*	8	30*	19*	---	119
1963	---	---	---	4	5	15	11	23*	14*	24*	---	11	107
1964	---	---	---	---	7	5*	22*	18*	28*	14	11*	6	111
1965	2	---	---	2	5	12*	19*	23*	25*	14	6	---	108
1966	---	---	---	5	11	6	7*	16*	23*	11	4	3	84
1967	---	---	2	7	---	4	14*	10	32*	21*	21*	---	111
1968	---	---	---	6	1	7	6	8	32*	19	18*	---	96
1969	5	---	---	5	---	---	8	6	10	18	10*	---	62
1970	---	5	---	---	---	2	5	24*	16	21*	6	---	79
TOTAL	7	5	10	46	41	63	132	234	230	229	112	56	1165

*Two typhoons occurring on the same day are counted as two typhoon days.

TABLE 4-4

LIST OF METEOROLOGICAL DATA, ESTIMATED CASUALTIES, AND
AFFECTED GEOGRAPHICAL LOCATIONS FOR THE TYPHOON SEASON 1970

TYPHOON	MINIMUM PRESSURE (MB)	MAXIMUM WIND (KT)	DEATHS	MISSING	PRINCIPAL AREAS AFFECTED
NANCY	949	120	---	---	Yap and the Philippines
OLGA	904	140	37	---	Ryukyu's, Japan, and Korea
WILDA	939	105	11	1	Ryukyu's and Japan
ANITA	912	135	23	4	Japan
BILLIE	945	110	15	---	Ryukyu's and Korea
CLARA	965	85	---	---	Remained over water
GEORGIA	904	140	95	80	Philippines, Hong Kong, and South China
HOPE	895	150	---	---	Chi Chi Jima Island
IRIS	944	100	---	---	Parcel Islands
JOAN	901	150	575	193	Philippines, Parcel Islands, Hong Kong, and South China
KATE	938	130	631	284	Philippines and Vietnam
PATSY	918	135	241	351	Philippines and Vietnam
TOTAL			1,628	913	

TABLE 4-5

As a result of this abnormal synoptic pattern, tradewind-produced cyclonic wind shear was weak as was the mechanism for mass transport towards developing depression centers. Both of these environmental conditions have been emphasized by Simpson (1971) as important for development.

The most striking period of inactivity was the lack of development during the month of July. Usually averaging 2 typhoons, the period was void of generation for the first time in 23 years dating back to 1947. Mean 700 mb height anomaly pattern for July indicated a blocking ridge situation over eastern Siberia with below normal geopotential heights in the subtropics west of Wake Island (Green, 1970). It is a similar pattern to that shown unfavorable for development in the Atlantic (Sugg and Hebert, 1969). A weak persistent trough extended from the mid-latitudes east of Japan into the tropics near the Marianas chain during most of the month slowly retrograding during the latter portion. Thus easterly flow across the tropical West Pacific was generally disrupted and underdeveloped--a condition not favored for typhoon generation.

The upper-tropospheric Mid-Pacific trough, noted by Sadler (1967) as a secondary source of typhoons, acted as an initiator in half of the dozen cases recorded during 1970. This semi-permanent climatological feature was the prime impetus for typhoons during August and early September. The axis of the shearline reached westward from Midway to the vicinity of Marcus Island during this period. Four cyclonic cells on its westward extension penetrated downward inducing surface troughs in the easterlies which later developed into typhoons Wilda, Anita, Clara, and Georgia.

The percentage of typhoons that became unusually severe was high as seven of the year's twelve crossed the super typhoon threshold (130 knots or greater). The Republic of the Philippines was especially hard hit as four of these extreme storms delivered their brunt to the archipelago within a three month period (see Table 4-5). Georgia led the succession in September followed by Joan and Kate in October and culminated in Patsy's direct strike on the metropolitan area of Manila in November. The total loss of life in the Philippines as a result of these storms is estimated near 1,550 with an additional 900 persons missing.

As damage and casualty statistics are incomplete for the West Pacific for the 1970 season, mention is made on an individual basis for each storm narrative. Figures were based on data from the Office of the High Commissioner - Trust Territory of the Pacific Islands, Royal Observatory of Hong Kong, Weather Bureau of the Republic of the Philippines, Japan Meteorological Agency, and the Environmental Data Service - National Oceanic and Atmospheric Administration.

1970 TROPICAL CYCLONES

CYCLONE	TYPE	NAME	DATE*	CALENDAR DAYS OF WARNING	MAX SFC WIND*	MIN OBS SLP	MAX RADIUS SFC CIRC	WARNINGS ISSUED		
								TOTAL	NO. AS TYPHOONS	DISTANCE TRAVELED*
01	T	NANCY	19 FEB-27 FEB	9	120	949	400	31	19	2,148
02	T	OLGA	28 JUN-05 JUL	8	140	904	360	29	22	2,382
03	TS	PAMELA	29 JUN-30 JUN	4	55	980	120	6	0	385
04	TS	RUBY	11 JUL-16 JUL	6	50	984	240	18	0	922
05	TS	SALLY	20 JUL-22 JUL	3	40	989	300	9	0	126
06	TD	----	28 JUL-30 JUL	3	30	993	180	13	0	826
07	TD	----	01 AUG-02 AUG	2	30	1001	180	5	0	423
08	TS	THERESA	01 AUG-03 AUG	3	40	988	120	5	0	993
09	TS	VIOLET	05 AUG-09 AUG	5	40	990	420	14	0	770
10	T	WILDA	08 AUG-15 AUG	8	105	939	540	27	19	1,860
11	T	ANITA	15 AUG-22 AUG	8	135	912	480	26	19	2,001
12	T	BILLIE	23 AUG-31 AUG	9	110	946	600	34	24	1,697
13	T	CLARA	24 AUG-03 SEP	11	85	965	420	34	13	2,449
14	H	DOT	(NAME GIVEN TO CENTRAL PACIFIC HURRICANE CENTER, HONOLULU)							
15	TS	ELLEN	03 SEP-05 SEP	3	40	984	180	9	0	1,206
16	TS	FRAN	04 SEP-07 SEP	4	55	976	300	15	0	1,731
17	T	GEORGIA	07 SEP-14 SEP	8	140	904	420	26	19	1,718
18	T	HOPE	19 SEP-29 SEP	11	150	895	360	37	27	3,034
19	T	IRIS	03 OCT-08 OCT	6	100	944	180	18	11	492
20	TD	----	04 OCT	1	30	1006	150	4	0	60
21	T	JOAN	09 OCT-18 OCT	10	150	901	720	34	25	2,254
22	T	KATE	14 OCT-25 OCT	12	130	938	540	42	34	2,317
23	TS	LOUISE	26 OCT-28 OCT	3	60	978	360	9	0	633
24	TS	MARGE	27 OCT-06 NOV	11	55	987	240	32	0	1,239
25	TS	NORA	31 OCT-03 NOV	4	50	1002	240	6	0	377
26	TS	OPAL	10 NOV-17 NOV	8	50	991	180	14	0	773
27	T	PATSY	14 NOV-22 NOV	9	135	918	600	33	19	2,917
28	TS	RUTH	24 NOV-29 NOV	6	40	995	240	3	0	391

1970 TOTALS

175

533

251

*Data Taken From Best Track

TABLE 4-6

1970 TROPICAL STORM AND DEPRESSION POSITION DATA

TROPICAL STORM PAMELA
29 JUN - 1 JUL

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	29/0500Z	7.1N	127.7E	7.7N	127.7E	7.8N	126.6E
02	29/1100Z	7.6N	127.3E	8.4N	127.6E	8.6N	126.3E
03	29/1700Z	8.9N	127.2E	9.2N	127.0E	11.3N	126.3E
04	29/2300Z	10.0N	126.0E	9.9N	125.9E	12.5N	122.8E
05	30/0500Z	10.4N	124.9E	10.3N	125.1E	12.5N	121.5E
06	30/1100Z	10.7N	124.3E	10.7N	124.4E	-	-

TROPICAL STORM RUBY
11 JUL - 16 JUL

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	11/2300Z	9.7N	128.5E	8.1N	131.3E	10.8N	125.5E
02	12/0500Z	10.0N	127.7E	9.2N	128.7E	11.1N	124.7E
03	12/1100Z	10.7N	127.2E	10.3N	127.8E	12.7N	124.7E
04	12/1700Z	11.5N	126.9E	12.7N	126.4E	13.9N	124.8E
05	12/2300Z	14.1N	125.8E	13.9N	125.8E	17.7N	122.2E
06	13/0500Z	14.9N	124.5E	14.7N	124.7E	18.6N	120.7E
07	13/1100Z	15.8N	123.4E	16.0N	123.8E	19.6N	120.1E
08	13/1700Z	17.4N	122.2E	17.2N	122.8E	21.8N	119.5E
09	13/2300Z	18.2N	121.9E	18.2N	121.5E	23.3N	119.7E
10	14/0500Z	19.5N	120.9E	18.7N	120.5E	24.3N	119.5E
11	14/1100Z	19.0N	118.2E	18.7N	119.3E	20.7N	116.3E
12	14/1700Z	19.4N	117.8E	19.2N	118.3E	20.9N	115.9E
13	14/2300Z	19.9N	117.7E	19.8N	117.6E	21.6N	115.3E
14	15/0500Z	20.2N	116.9E	20.2N	116.7E	22.2N	114.0E
15	15/1100Z	20.8N	116.3E	20.8N	116.0E	22.8N	112.8E
16	15/1700Z	21.3N	115.5E	21.3N	115.5E	23.1N	112.0E
17	15/2300Z	21.7N	114.8E	21.9N	115.0E	24.0N	111.5E
18	16/0500Z	23.1N	114.6E	22.6N	114.8E	-	-

TROPICAL STORM SALLY
20 JUL - 22 JUL

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	20/0500Z	26.2N	161.9E	26.0N	162.2E	28.5N	164.6E
02	20/1100Z	26.8N	162.3E	26.8N	162.5E	29.1N	163.9E
03	20/1700Z	26.7N	162.9E	27.7N	162.6E	28.5N	165.9E
04	20/2300Z	28.5N	162.8E	28.6N	162.7E	34.8N	163.9E
05	21/0500Z	29.8N	162.6E	29.8N	162.6E	35.8N	164.6E
06	21/1100Z	31.7N	162.5E	31.1N	162.3E	-	-
07	21/1700Z	32.6N	161.7E	32.2N	161.7E	33.8N	158.0E
08	21/2300Z	33.2N	160.8E	33.1N	161.2E	33.7N	157.3E
09	22/0500Z	34.9N	161.1E	34.7N	161.1E	-	-

TROPICAL DEPRESSION 06
28 JUL - 31 JUL

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	28/0500Z	26.2N	136.3E	26.3N	136.3E	27.1N	130.5E
02	28/1100Z	26.4N	134.7E	26.8N	135.3E	27.2N	129.4E
03	28/1700Z	26.6N	133.6E	27.3N	134.4E	27.3N	128.9E
04	28/2300Z	27.6N	133.5E	27.7N	133.3E	29.5N	129.7E
05	29/0500Z	28.1N	132.5E	27.9N	132.3E	29.8N	129.1E
06	29/1100Z	28.3N	131.3E	28.2N	131.5E	29.6N	128.2E
07	29/1700Z	28.5N	131.0E	28.5N	131.1E	29.7N	128.2E
08	29/2300Z	29.0N	130.9E	29.2N	130.7E	30.0N	131.0E
09	30/0500Z	30.1N	130.6E	29.8N	130.5E	33.0N	131.2E
10	30/1100Z	30.7N	130.5E	30.3N	130.3E	33.8N	131.6E
11	30/1700Z	30.8N	130.1E	30.6N	129.6E	-	-
12	30/2300Z	30.2N	129.1E	30.6N	128.8E	34.2N	129.5E
13	31/0500Z	31.2N	128.4E	-	-	-	-

TROPICAL DEPRESSION 07
1 AUG - 2 AUG

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	01/0500Z	21.5N	123.0E	21.5N	122.8E	22.1N	121.9E
02	01/1100Z	21.9N	121.1E	21.7N	121.6E	23.8N	117.3E

TROPICAL DEPRESSION 07 (Cont'd)
1 AUG - 2 AUG

WARNING		WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
<u>NO.</u>	<u>DTG</u>	<u>LAT</u>	<u>LONG</u>	<u>LAT</u>	<u>LONG</u>	<u>LAT</u>	<u>LONG</u>
03	01/1700Z	22.3N	120.3E	22.3N	120.3E	24.3N	116.6E
04	01/2300Z	23.0N	118.8E	22.9N	118.7E	-	-
05	02/0500Z	23.4N	117.0E	23.4N	117.0E	-	-

TROPICAL STORM THERESE
2 AUG - 3 AUG

WARNING		WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
<u>NO.</u>	<u>DTG</u>	<u>LAT</u>	<u>LONG</u>	<u>LAT</u>	<u>LONG</u>	<u>LAT</u>	<u>LONG</u>
01	02/2300Z	34.9N	165.5E	34.4N	165.5E	44.3N	169.2E
02	03/0500Z	37.2N	165.6E	37.2N	166.2E	-	-
03	03/1100Z	39.0N	167.5E	39.7N	167.9E	-	-
04	03/1700Z	41.2N	169.6E	42.2N	169.8E	-	-
05	03/2300Z	44.6N	171.0E	44.6N	170.9E	-	-

TROPICAL STORM VIOLET
5 AUG - 9 AUG

WARNING		WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
<u>NO.</u>	<u>DTG</u>	<u>LAT</u>	<u>LONG</u>	<u>LAT</u>	<u>LONG</u>	<u>LAT</u>	<u>LONG</u>
01	05/2300Z	15.7N	124.0E	15.0N	124.0E	17.0N	123.3E
02	06/0500Z	15.2N	123.6N	15.3N	123.6E	16.8N	123.0E
03	06/1100Z	15.7N	123.4E	15.7N	123.4E	17.0N	122.2E
04	06/1700Z	15.8N	123.1E	16.1N	122.6E	17.4N	121.8E
05	06/2300Z	16.6N	122.0E	16.6N	121.9E	18.7N	120.0E
06	07/0500Z	17.7N	121.0E	17.7N	120.9E	20.1N	117.7E
07	07/1100Z	18.3N	120.0E	17.9N	119.6E	20.6N	116.1E
08	07/1700Z	18.6N	118.7E	18.6N	118.7E	20.8N	114.1E
09	07/2300Z	19.2N	117.5E	19.3N	117.5E	21.3N	112.6E
10	08/0500Z	19.6N	116.7E	19.7N	116.8E	21.5N	112.2E
11	08/1100Z	20.2N	115.7E	20.3N	115.7E	21.8N	111.1E
12	08/1700Z	20.7N	114.6E	20.8N	114.6E	22.1N	110.0E
13	08/2300Z	21.1N	113.6E	21.1N	113.6E	-	-
14	09/0500Z	21.7N	112.5E	21.7N	112.5E	-	-

TROPICAL STORM ELLEN
3 SEP - 5 SEP

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	04/0500Z	23.5N	135.7E	22.9N	136.1E	25.8N	132.0E
02	04/1100Z	24.3N	134.6E	24.1N	134.7E	26.8N	128.7E
03	04/1700Z	25.2N	133.2E	25.3N	133.0E	27.1N	127.0E
04	04/2300Z	26.3N	130.5E	26.3N	130.5E	27.4N	122.2E
05	05/0500Z	26.5N	128.2E	26.3N	128.0E	-	-
06	05/1100Z	25.7N	125.5E	25.7N	125.5E	-	-
07	05/1700Z	24.1N	124.8E	24.2N	124.9E	-	-
08	05/2300Z	24.0N	125.8E	24.5N	125.7E	-	-

TROPICAL STORM FRAN
4 SEP - 7 SEP

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	04/1100Z	20.6N	127.2E	20.6N	127.7E	20.6N	125.1E
02	04/1700Z	20.6N	126.6E	20.9N	128.6E	20.6N	124.5E
03	04/2300Z	21.7N	129.5E	21.7N	129.5E	25.1N	130.7E
04	05/0500Z	23.0N	130.0E	22.9N	130.1E	27.7N	128.9E
05	05/1100Z	24.4N	130.5E	24.2N	130.0E	27.2N	129.4E
06	05/1700Z	25.5N	128.9E	25.6N	128.8E	23.5N	126.1E
07	05/2300Z	26.5N	126.7E	26.5N	126.7E	27.2N	122.7E
08	06/0500Z	25.9N	124.9E	26.2N	124.7E	27.0N	123.1E
09	06/1100Z	26.3N	122.3E	25.9N	123.0E	-	-
10	06/1700Z	26.2N	121.2E	25.3N	121.8E	-	-
11	06/2300Z	24.8N	120.7E	24.9N	120.8E	-	-
12	07/0500Z	24.8N	120.2E	24.8N	120.1E	-	-
13	07/1100Z	24.8N	119.4E	24.8N	119.5E	-	-
14	07/1700Z	24.9N	119.0E	25.0N	118.9E	-	-
15	07/2300Z	25.4N	118.5E	25.2N	118.3E	-	-

TROPICAL DEPRESSION 20
4 SEP

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	04/0500Z	10.0N	151.0E			11.7N	147.3E
02	04/1100Z	10.5N	150.1E			11.9N	146.3E

TROPICAL DEPRESSION 20 (Cont'd)
4 SEP

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
03	04/1700Z	10.9N	149.3E			12.1N	145.9E
04	04/2300Z	10.5N	149.0E			-	-

TROPICAL STORM MARGE
27 OCT - 6 NOV

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	28/0500Z	12.2N	142.2E	12.2N	142.0E	13.6N	137.5E
02	28/1100Z	12.5N	140.6E	12.4N	140.7E	13.1N	135.4E
03	28/1700Z	12.4N	139.3E	12.5N	139.2E	12.8N	134.4E
04	28/2300Z	12.6N	137.5E	12.7N	137.5E	12.8N	131.7E
05	29/0500Z	13.8N	135.7E	13.3N	136.7E	15.5N	129.3E
06	29/1100Z	13.3N	134.3E	13.3N	134.3E	-	-
07	30/1100Z	14.7N	130.5E	14.9N	130.2E	14.9N	128.4E
08	30/1700Z	14.8N	130.0E	15.2N	129.2E	14.9N	127.8E
09	30/2300Z	14.7N	127.8E	15.4N	128.1E	14.4N	122.9E
10	31/0500Z	15.6N	127.1E	15.5N	127.1E	16.5N	123.1E
11	31/1100Z	15.0N	125.6E	15.0N	125.6E	13.4N	120.2E
12	31/1700Z	14.4N	124.2E	14.3N	124.3E	-	-
13	31/2300Z	13.7N	122.9E	13.9N	123.1E	-	-
14	01/0500Z	13.7N	122.1E	13.7N	122.1E	-	-
15	02/0500Z	14.1N	118.1E	14.1N	118.4E	13.3N	115.2E
16	02/1100Z	14.1N	117.8E	14.2N	117.8E	14.1N	115.2E
17	02/1700Z	14.5N	116.9E	14.6N	117.2E	14.5N	113.9E
18	02/2300Z	14.7N	116.9E	14.7N	116.9E	15.2N	115.0E
19	03/0500Z	14.8N	116.6E	14.8N	116.8E	15.0N	114.8E
20	03/1100Z	14.9N	116.8E	14.4N	116.5E	14.7N	115.5E
21	03/1700Z	14.3N	116.4E	14.4N	116.5E	13.7N	114.6E
22	03/2300Z	14.3N	116.3E	14.4N	116.5E	13.6N	114.8E
23	04/0500Z	14.5N	116.6E	14.9N	116.3E	14.5N	116.6E
24	04/1100Z	15.3N	115.8E	15.3N	115.7E	17.2N	115.7E
25	04/1700Z	15.7N	115.0E	15.8N	115.0E	16.2N	112.1E
26	04/2300Z	15.9N	114.3E	15.7N	114.5E	16.2N	111.3E
27	05/0500Z	15.8N	114.5E	15.5N	114.5E	15.8N	113.9E
28	05/1100Z	15.4N	114.6E	15.6N	114.7E	15.4N	114.0E
29	05/1700Z	15.7N	114.0E	15.8N	113.9E	15.4N	112.7E
30	05/2300Z	15.8N	113.6E	15.8N	113.5E	15.3N	112.0E
31	06/0500Z	15.7N	112.8E	15.9N	112.9E	-	-
32	06/1100Z	16.1N	112.4E	16.1N	112.5E	-	-

TROPICAL STORM LOUISE
27 OCT - 29 OCT

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	27/0500Z	11.7N	115.5E	11.8N	115.5E	12.0N	111.0E
02	27/1100Z	12.1N	114.4E	12.1N	114.4E	12.3N	110.1E
03	27/1700Z	12.3N	113.5E	12.3N	112.9E	12.3N	109.4E
04	27/2300Z	12.5N	111.6E	12.3N	111.5E	-	-
05	28/0500Z	12.2N	109.9E	11.9N	110.3E	-	-
06	28/1100Z	11.7N	109.4E	11.6N	109.5E	-	-
07	28/1700Z	11.3N	108.5E	11.2N	108.5E	-	-
08	28/2300Z	11.0N	107.5E	10.9N	107.5E	-	-
09	29/0500Z	11.3N	106.5E	-	-	-	-

TROPICAL STORM NORA
2 NOV - 3 NOV

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	02/0500Z	7.8N	107.0E	8.8N	107.1E	7.8N	103.5E
02	02/1100Z	7.8N	106.1E	7.8N	106.3E	7.9N	102.9E
03	02/1700Z	7.8N	105.6E	7.8N	105.6E	7.9N	102.9E
04	02/2300Z	7.8N	104.9E	7.8N	104.9E	7.9N	102.2E
05	03/0500Z	7.8N	104.2E	7.9N	104.4E	8.1N	101.4E
06	03/1100Z	8.0N	103.8E	8.1N	103.8E	-	-

TROPICAL STORM OPAL
13 NOV - 17 NOV

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	13/2300Z	15.1N	118.2E	15.1N	118.2E	15.4N	115.3E
02	14/0500Z	15.4N	117.2E	15.4N	117.3E	15.2N	113.7E
03	14/1100Z	15.6N	116.4E	15.6N	116.3E	15.1N	113.4E
04	14/1700Z	15.6N	115.5E	15.7N	115.3E	14.8N	112.6E
05	14/2300Z	15.4N	114.3E	15.5N	114.5E	14.3N	111.0E
06	15/0500Z	15.5N	114.4E	15.2N	114.1E	15.2N	112.8E
07	15/1100Z	14.6N	113.3E	14.7N	113.2E	13.1N	109.9E
08	15/1700Z	14.3N	112.7E	14.3N	112.5E	13.0N	109.7E
09	15/2300Z	13.8N	111.8E	13.7N	111.9E	12.7N	108.3E
10	16/0500Z	12.8N	111.3E	12.8N	111.4E	10.9N	108.2E
11	16/1100Z	11.8N	111.0E	11.8N	110.8E	9.0N	108.1E
12	16/1700Z	10.8N	110.5E	10.8N	110.2E	8.5N	107.8E
13	16/2300Z	9.9N	109.3E	9.9N	109.1E	-	-
14	17/0500Z	9.4N	107.8E	9.4N	107.9E	-	-

TROPICAL STORM RUTH
24 NOV - 29 NOV

WARNING NO.	DTG	WARNING POSIT		BEST TRACK		24 HOUR FORECAST POSIT	
		LAT	LONG	LAT	LONG	LAT	LONG
01	27/0500Z	8.7N	108.5E	8.8N	108.4E	8.2N	105.7E
02	27/1100Z	8.2N	107.7E	8.5N	107.2E	7.2N	104.6E
03	27/1700Z	7.8N	106.5E	8.4N	106.1E	-	-

Forecast positions for the 24, 48, and 72 hour forecasts are verified only as long as the best track analysis estimates winds in excess of 33 knots for tropical cyclones which reach typhoon intensity.

In addition to this method of verifying absolute error distance, a computation of closest distance to the best track (right angle error) has been included to indicate the demonstrated ability to forecast the path of motion without regard to speed.

The following tables and figures are presented to graphically depict the distribution of forecasting error in JTWC forecasts.

FORECAST VERIFICATION
AVERAGE ERROR (NAUTICAL MILES)

	<u>24 HR</u>	<u>48 HR</u>	<u>72 HR</u>
1950-58	170	---	---
1959	*117	*267	---
1960	177	354	---
1961	136	274	---
1962	144	287	476
1963	127	246	374
1964	133	284	429
1965	151	303	418
1966	136	280	432
1967	125	276	414
1968	105	229	337
1969	111	237	349
1970	98	181	272

*FORECAST POSITIONS NORTH OF 35N WERE NOT VERIFIED.

TABLE 4-7

JTWC OFFICIAL FORECAST ACCURACY

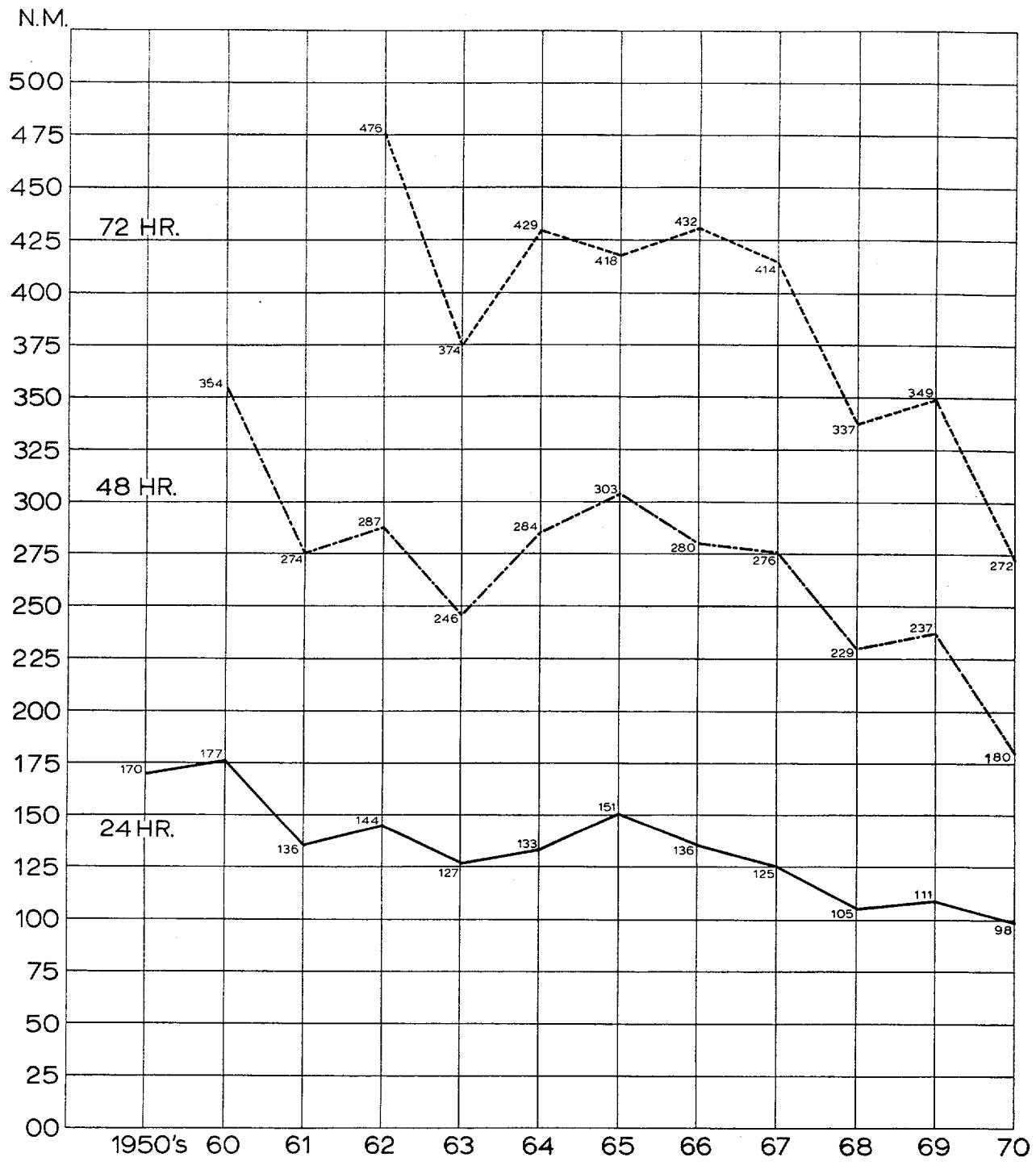


FIGURE 4-1

JOINT TYPHOON WARNING CENTER ERROR SUMMARY

(Average errors are given in nautical miles)

CYCLONE	WRNG POSIT ERROR	# WRNGS	24 HR			48 HR			72 HR		
			FCST ERROR	RT ANGLE ERROR	# CASES	FCST ERROR	RT ANGLE ERROR	# CASES	FCST ERROR	RT ANGLE ERROR	# CASES
1. T. NANCY	14	31	85	67	27	190	128	23	322	166	10
2. T. OLGA	14	29	88	62	25	139	88	20	312	232	8
3. T.S. PAMELA	22	6	165	--	2	--	--	--	--	--	--
4. T.S. RUBY	31	18	124	--	14	331	--	6	228	--	1
5. T.S. SALLY	24	9	182	--	5	--	--	--	--	--	--
6. T.D.	24	13	99	--	8	--	--	--	--	--	--
7. T.D.	10	5	276	--	1	--	--	--	--	--	--
8. T.S. THERESE	37	5	72	--	1	--	--	--	--	--	--
9. T.S. VIOLET	12	14	84	--	10	217	--	5	--	--	--
10. T. WILDA	18	27	146	77	23	290	243	18	512	446	7
11. T. ANITA	19	26	100	41	22	202	88	16	323	136	6
12. T. BILLIE	16	34	85	62	30	169	151	22	315	232	9
13. T. CLARA	20	34	154	100	29	249	179	6	432	400	1
14. H. DOT	(CENTRAL PACIFIC HURRICANE CENTER)										
15. T.S. ELLEN	16	9	214	--	4	--	--	--	--	--	--
16. T.S. FRAN	25	15	(269)	--	8	454	--	6	438	--	2
17. T. GEORGIA	15	26	69	43	22	114	82	17	116	85	6
18. T. HOPE	16	37	101	85	32	204	167	24	242	185	9
19. T. IRIS	15	18	90	50	14	251	89	7	306	290	1
20. T.D.	30	4	--	--	--	--	--	--	--	--	--
21. T. JOAN	20	34	99	56	30	168	103	26	151	67	10
22. T. KATE	14	42	88	53	38	192	119	34	284	182	15
23. T.S. LOUISE	13	9	54	--	3	--	--	--	--	--	--
24. T.S. MARGE	16	32	100	--	24	202	--	10	256	--	4
25. T.S. NORA	16	6	48	--	2	--	--	--	--	--	--
26. T.S. OPAL	10	14	81	--	10	194	--	5	--	--	--
27. T. PATSY	22	33	(61)	38	27	101	41	23	166	53	10
28. T.S. RUTH	26	3	66	--	2	150	--	2	--	--	--
ALL FORECASTS	17.7	533	104	--	413	190	--	270	279	--	99
TYPHOONS	17.0	371	98	63	314	181	121	232	272	177	89

TABLE 4-8

LATITUDE STRATIFICATION OF 1970
FORECAST ERRORS

	<u>CASES</u>	<u>MEAN ERROR (N.M.)</u>
<u>24 Hour</u>		
Whole Sample	314	98
Below 20N	158	84
20N-30N	84	88
Below 30N	242	85
Above 30N	72	139
<u>48 Hour</u>		
Whole Sample	232	181
Below 20N	119	157
20N-30N	69	207
Below 30N	188	175
Above 30N	44	206
<u>72 Hour</u>		
Whole Sample	89	272
Below 20N	46	221
20N-30N	24	306
Below 30N	70	250
Above 30N	19	352

TABLE 4-9

INDIVIDUAL TYPHOONS
OF 1970
24 HOUR VERIFICATION ERROR

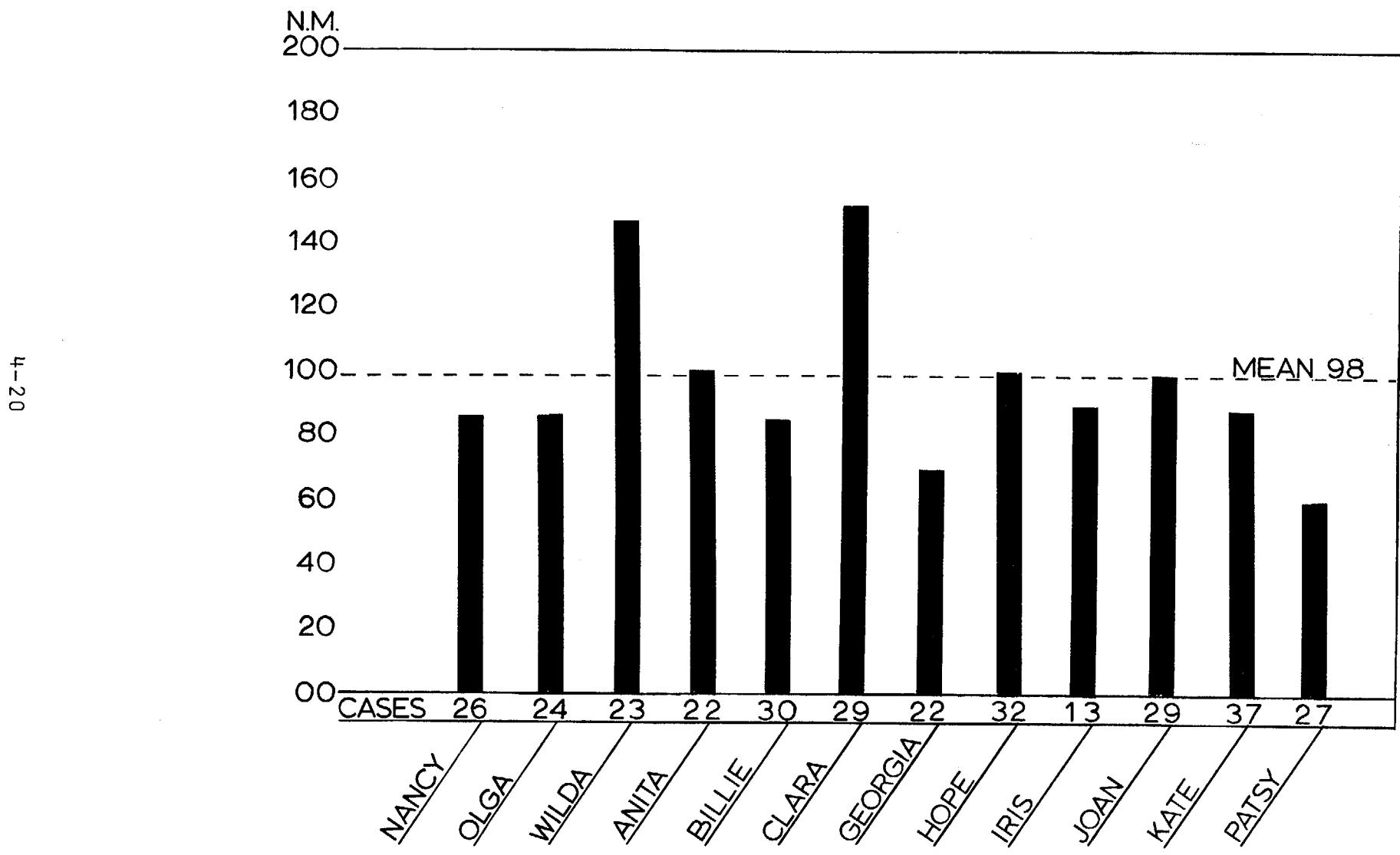


FIGURE 4-2

RIGHT ANGLE ERROR

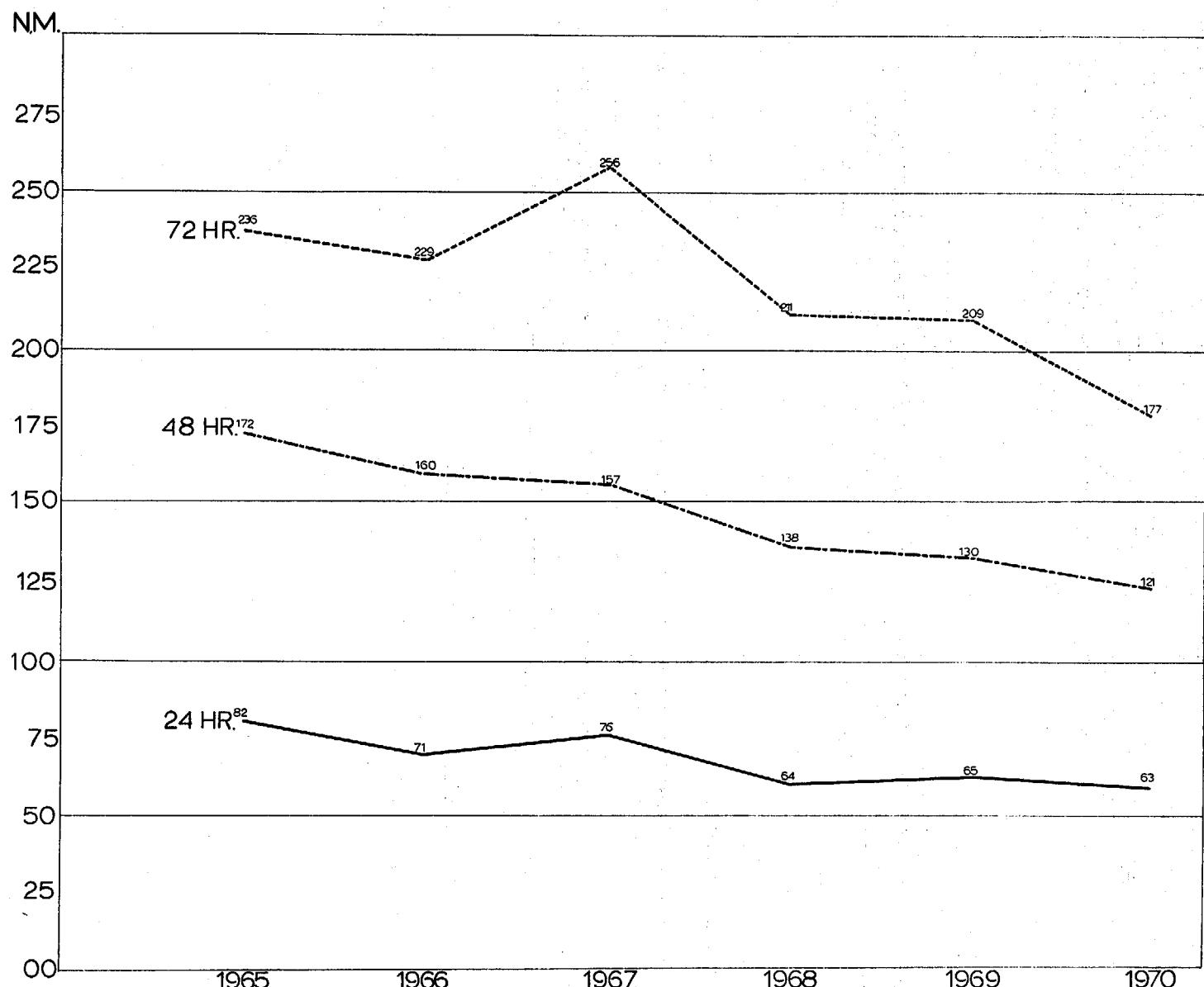


FIGURE 4-3

CONFIDENCE FORECASTING

Confidence forecasts were authorized for use during 1970. When a 24 hour vector error of over 130 miles was anticipated, a remark to this effect was included in the warning. The background and development of this method of confidence forecasting is covered in the 1969 Annual Typhoon Report (FWC/JTWC, 1969). It is felt that the use of this method of providing the user a feel for the forecaster's confidence in a particular forecast was quite useful and meaningful. Confidence statements were used 41 times during the year. Of those that verified, 25 or 68% verified with 24 hour errors over 130 miles. During the experimental stage of using this technique in 1969 (FWC/JTWC, 1969), only 47% verified. It may be that through experience and concentration, skill in recognizing the large error situations is improved.

A graphic evaluation of the results of using confidence forecasts during 1970 is contained in Figure 4-4. This graph portrays comparative cumulative percentage curves of the resultant average vector errors for normal forecasts vs. low confidence forecasts. The percentile error values for the low confidence forecasts are nearly twice those of average forecasts. Obviously all large error forecasts cannot be recognized but the data indicate that when one is recognized it is wise to include a larger margin of error in disaster preparedness planning or evasionary tactics.

These confidence forecasts will continue to be issued during 1971. Attempt will be made in-house during 1971 to refine and expand confidence forecasting in order to make them ever more meaningful and applicable to the 48 and 72 hour extended outlooks also.

A COMPARISON OF
CUMULATIVE ERROR DISTRIBUTIONS
OF ALL 1968-1970 24-HR FORECASTS
TO 1970 LOW CONFIDENCE FORECASTS

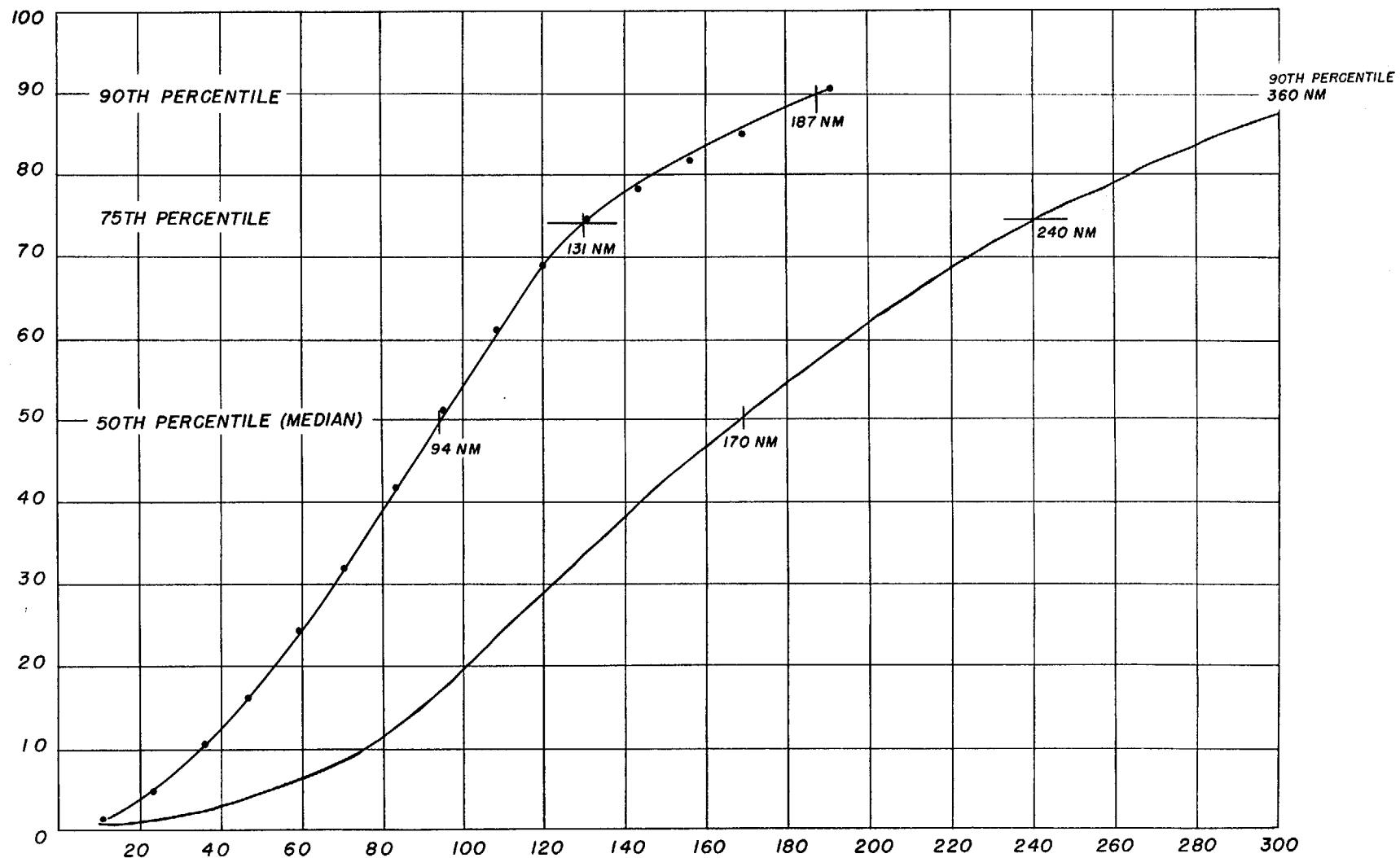


FIGURE 4-4

SUMMARY OF TROPICAL CYCLONE FORMATION ALERTS 1970

Early in 1970 CINCPAC authorized the use of the Tropical Cyclone Formation Alert message. This new message enabled JTWC to provide a form of warning in those situations in which significant tropical cyclone development was possible, but had not already taken place based on observational evidence.

During 1970 there were 32 tropical disturbances for which formation alerts were issued (Hurricane Dot excluded.) The total number of alerts, including extensions, was 57.

In summary,

1. Alerts were issued for 18 out of 27 numbered tropical cyclones.
 - a. Nine were superceded by tropical depression warnings.
 - b. Nine were superceded by tropical storm warnings.
2. Out of the 32 alert systems, 18 or 56% developed into tropical cyclones.*
3. Alerts by months.

J	F	M	A	M	J	J	A	S	O	N	D
0	1	3	1	0	2	3	7	5	4	5	1

*Typhoon Patsy and Tropical Storm Ruth each had two series of alerts issued prior to the initial tropical cyclone warning.

REFERENCES:

Green, R. A., "The Weather and Circulation of July 1970--
Variable Weather Ending in a Period of High Air Pollution
in the East, Persistently Warm in the Southwest," Monthly
Weather Review Vol. 98, No. 10, October 1970, pp789-790.

Sadler, J. C., "The Tropical Upper Tropospheric Trough as a
Secondary Source of Typhoons and a Primary Source of Trade-
wind Disturbances," Hawaii Institute of Geophysics, Univer-
sity of Hawaii, Final Report to Air Force Cambridge Research
Laboratories on Contract No. AF19(628)-3860, Bedford, Mass.,
March 1967, 44pp.

Simpson, R. H., "A Reassessment of the Hurricane Prediction
Problem," ESSA Technical Memorandum WBTM SR-50, February
1971, 16pp.

Sugg, A. L., and P. J. Herbert, "The Atlantic Hurricane Season
of 1968," Monthly Weather Review Vol. 97, No. 3, March
1969, p227.